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**Yoshida et al.**

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(54) **REACTOR HAVING RELAY MEMBER WITH INPUT/OUTPUT TERMINAL**

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***H01F 27/29*** (2006.01)
***H01F 27/30*** (2006.01)

(52) **U.S. Cl.**
CPC ..... ***H01F 27/29*** (2013.01); ***H01F 27/306*** (2013.01)

(58) **Field of Classification Search**
USPC ..... 336/198, 5, 55
See application file for complete search history.

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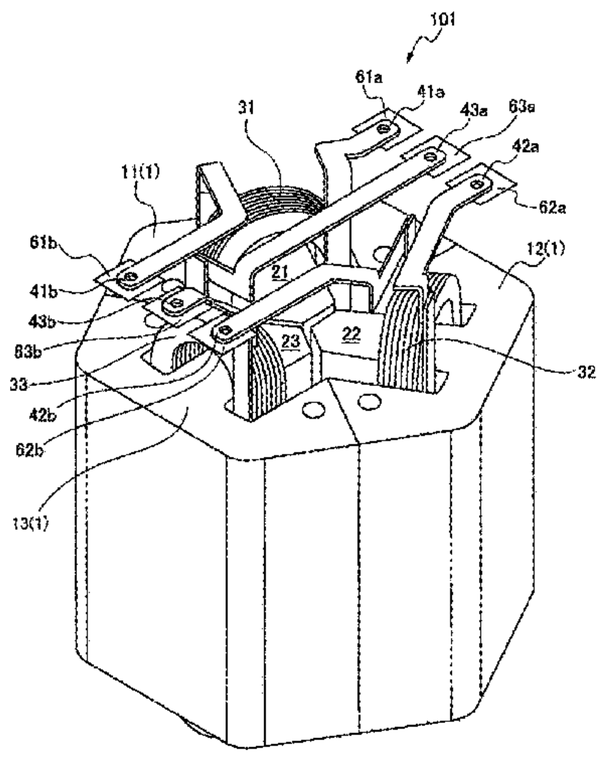
(57) **ABSTRACT**

A reactor includes: an outer peripheral iron core; three leg iron cores; and three coils, each of the coils having an input side coil end and an output side coil end projecting from a same end surface on an end side in the axial direction of the three leg iron cores, where the three coils include two first coils in which a projecting position of the input side coil end and a projecting position of the output side coil end has a first relative positional relationship and include one second coil having a second relative positional relationship opposite to the first relative positional relationship and where winding directions from the input side coil end to the output side coil end of the first and the second coils are reversed to each other.

**4 Claims, 8 Drawing Sheets**



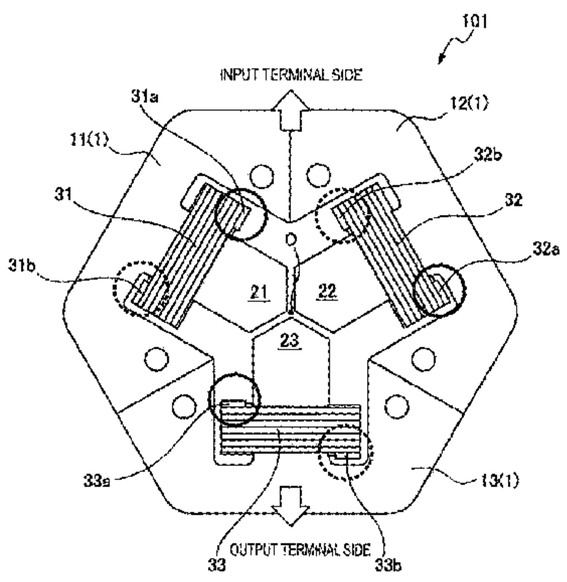



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FIG. 1A

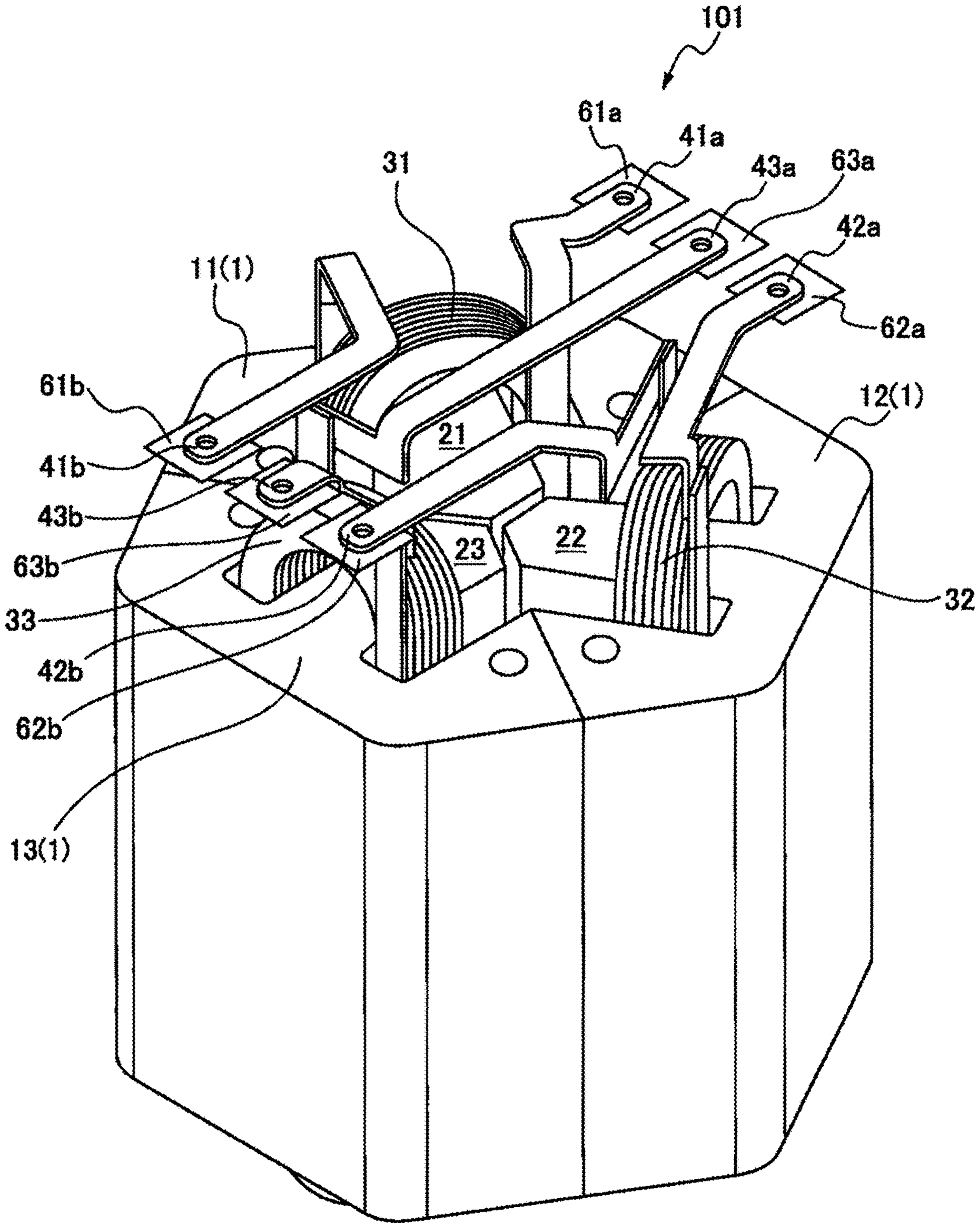

101
61a
41a
31
43a
63a
42a
62a
11(1)
61b
12(1)
41b
21
43b
22
23
63b
32
33
42b
62b
13(1)

FIG. 1B

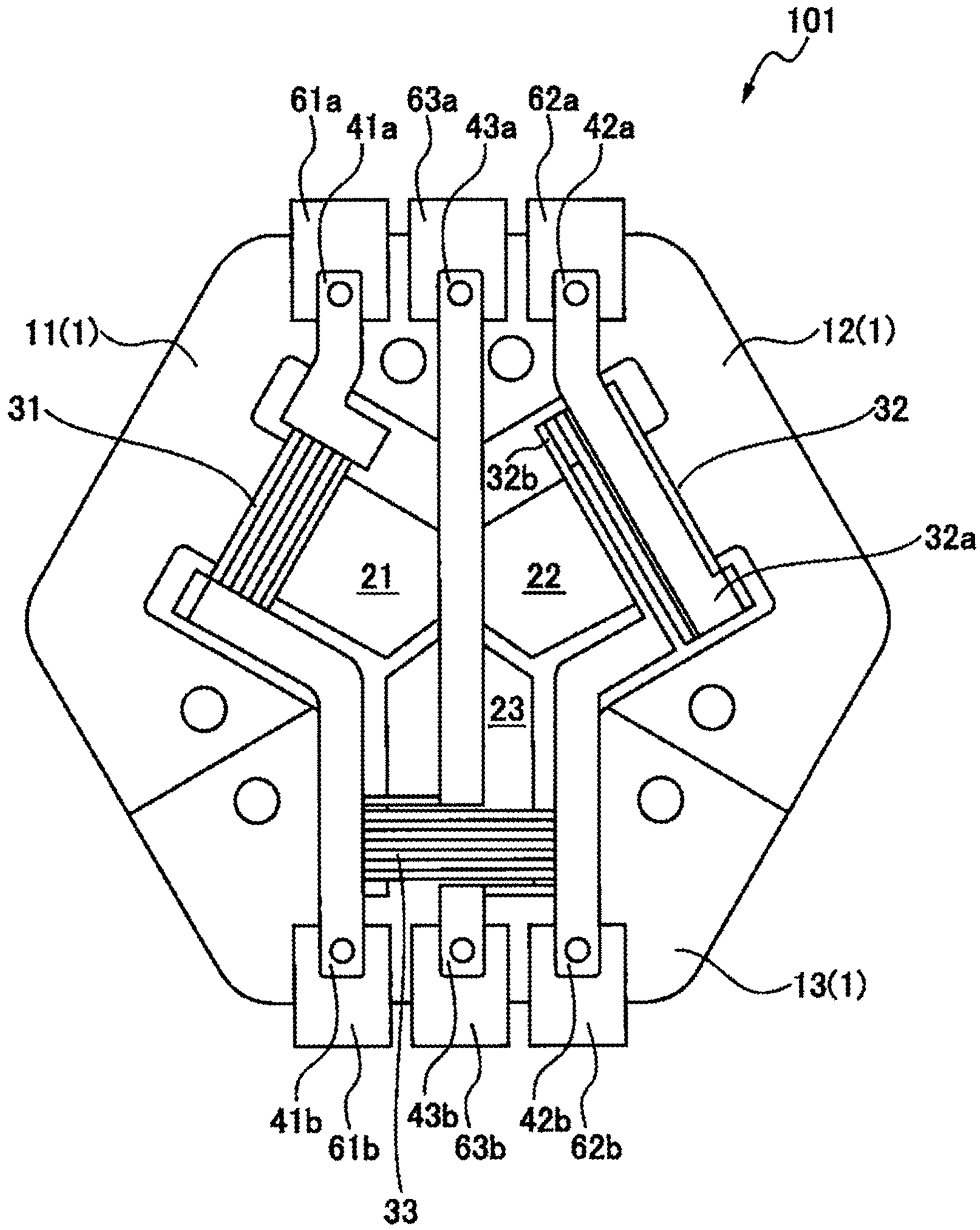

101
61a
41a
63a
43a
62a
42a
11(1)
12(1)
31
32
32b
32a
21
22
23
13(1)
41b
61b
33
43b
63b
42b
62b

FIG. 2

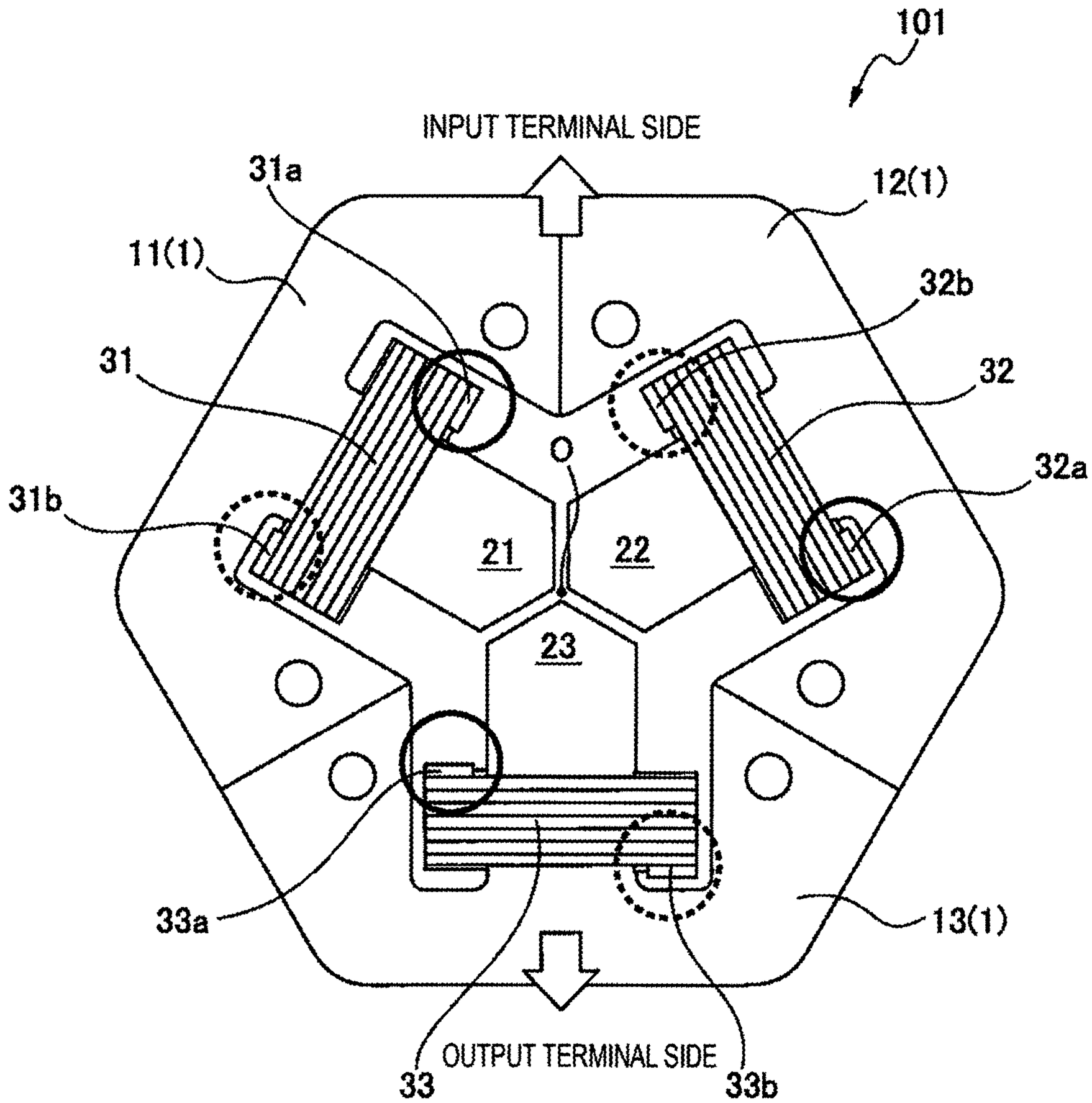

101
INPUT TERMINAL SIDE
31a
12(1)
11(1)
32b
31
32
32a
31b
21
22
23
33a
13(1)
OUTPUT TERMINAL SIDE
33
33b

FIG. 3A

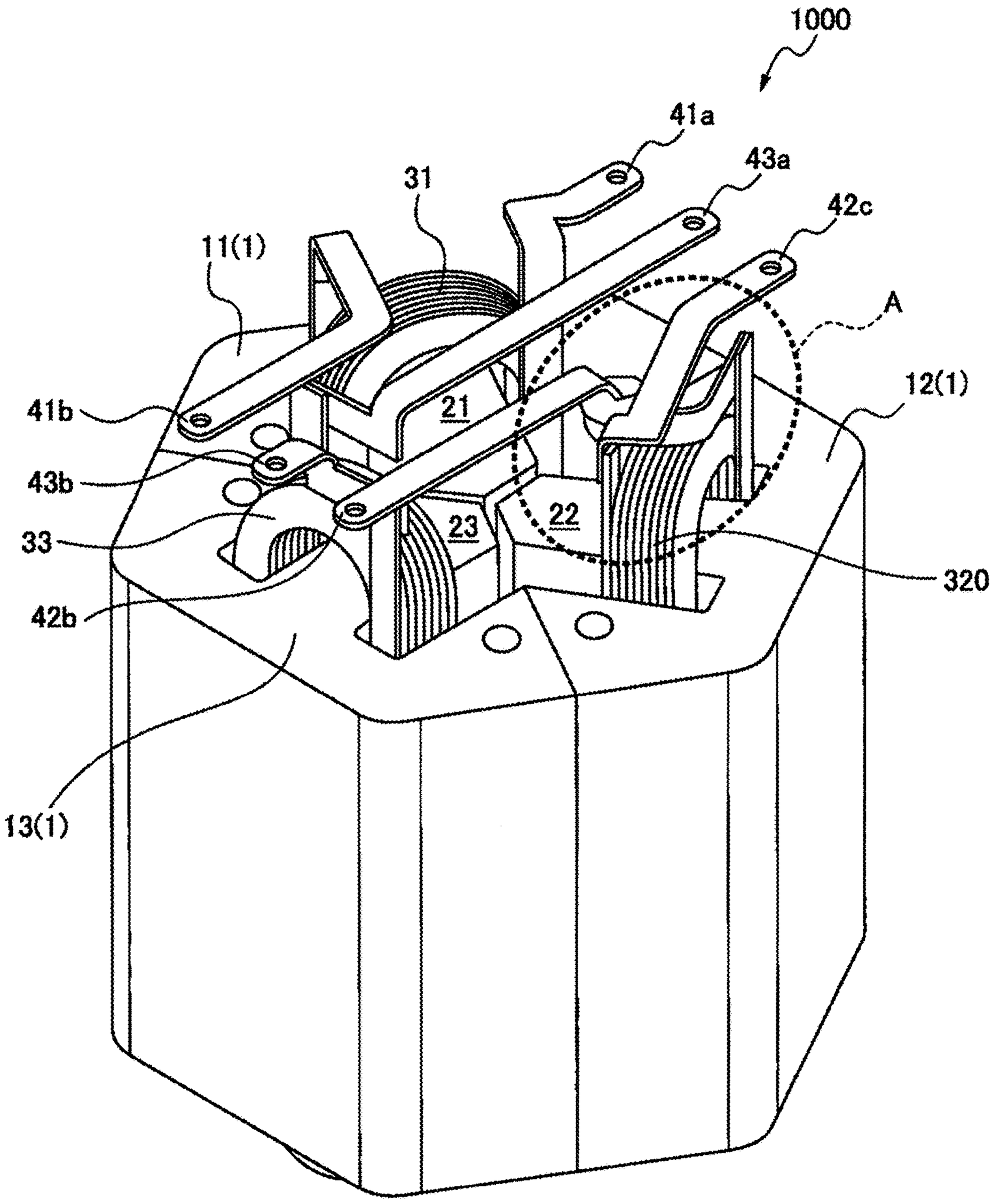


FIG. 3B

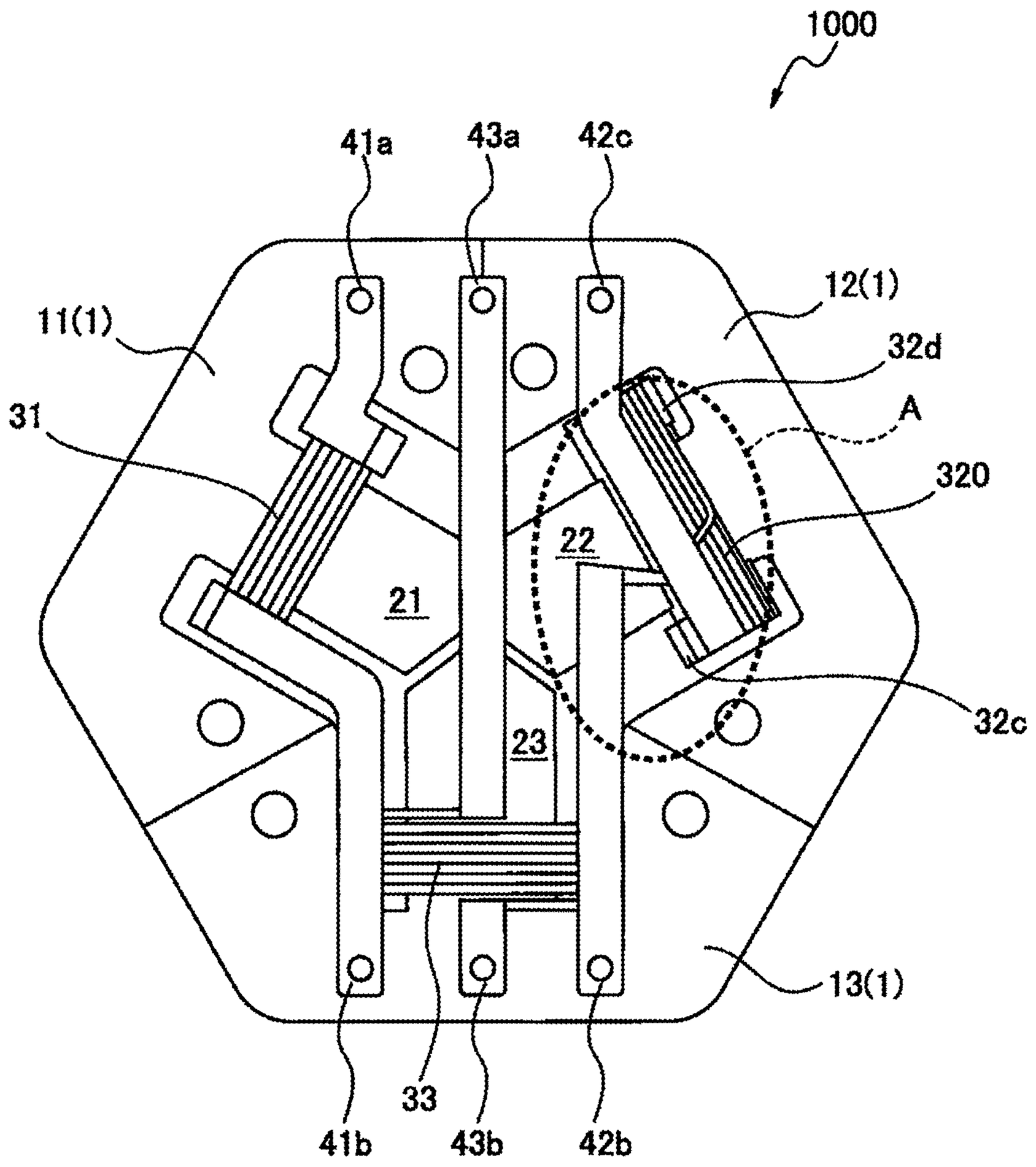

1000
41a
43a
42c
11(1)
12(1)
32d
31
A
320
22
21
23
32c
13(1)
33
41b
43b
42b

FIG. 4

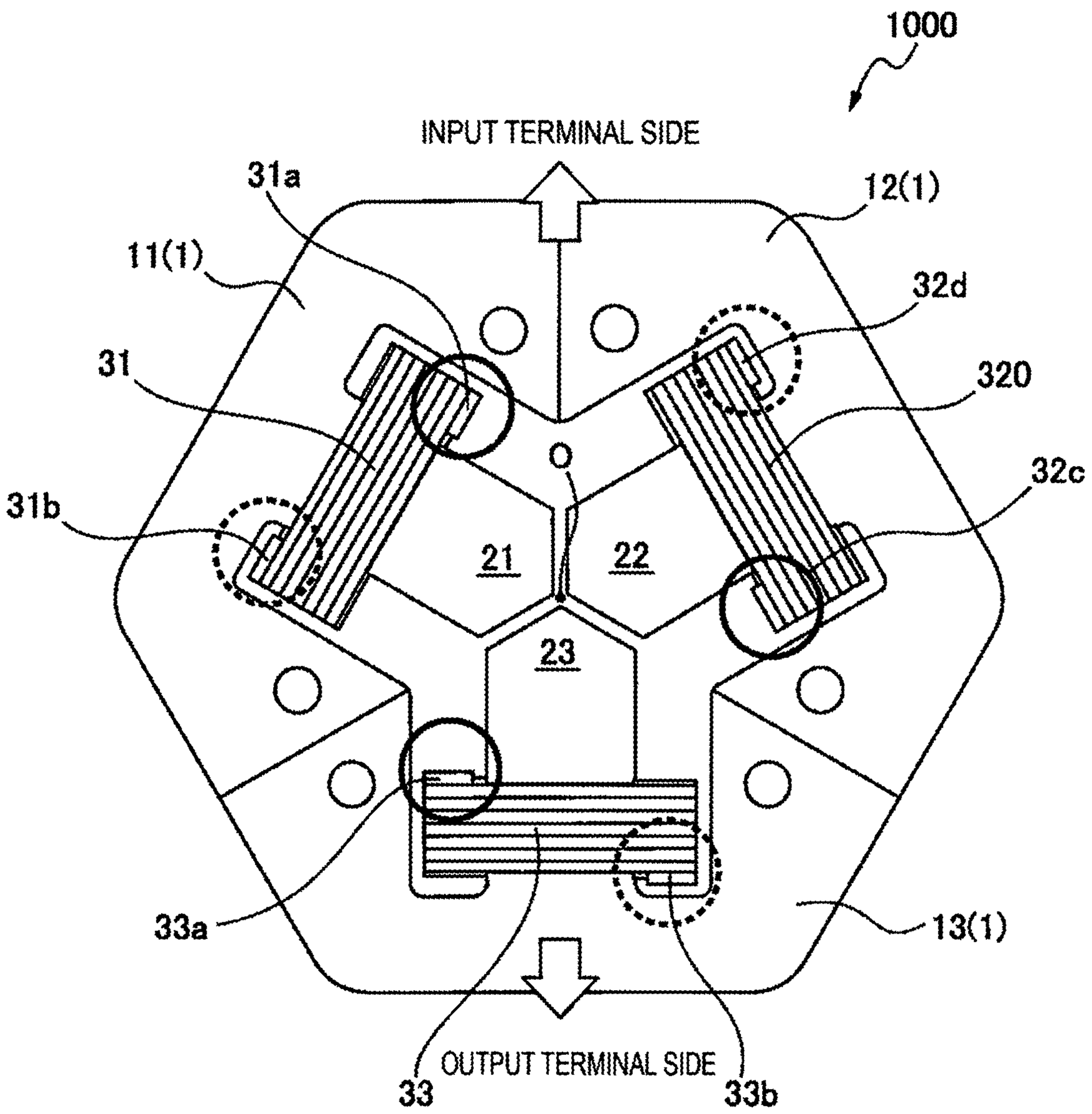

1000
INPUT TERMINAL SIDE
31a
12(1)
11(1)
32d
31
320
O
32c
31b
21
22
23
33a
13(1)
OUTPUT TERMINAL SIDE
33
33b

FIG. 5A

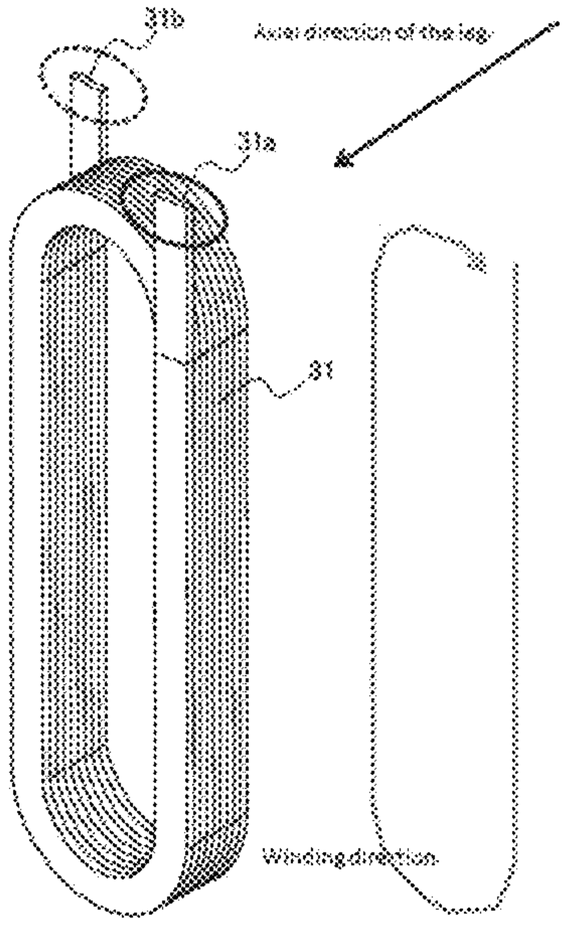

31b
Axial direction of the leg
31a
31
Winding direction

FIG. 5B

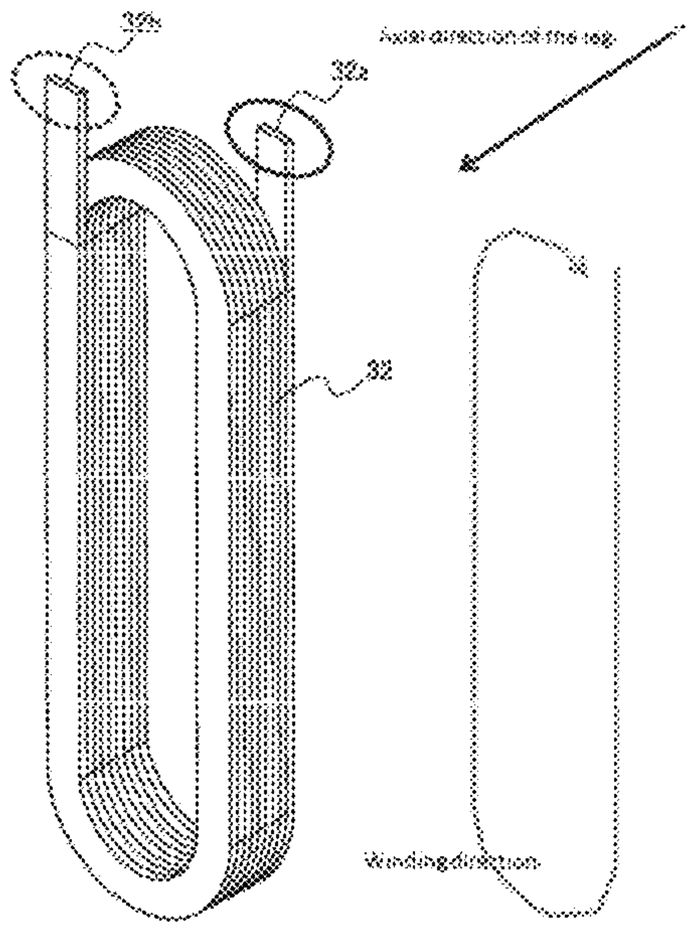
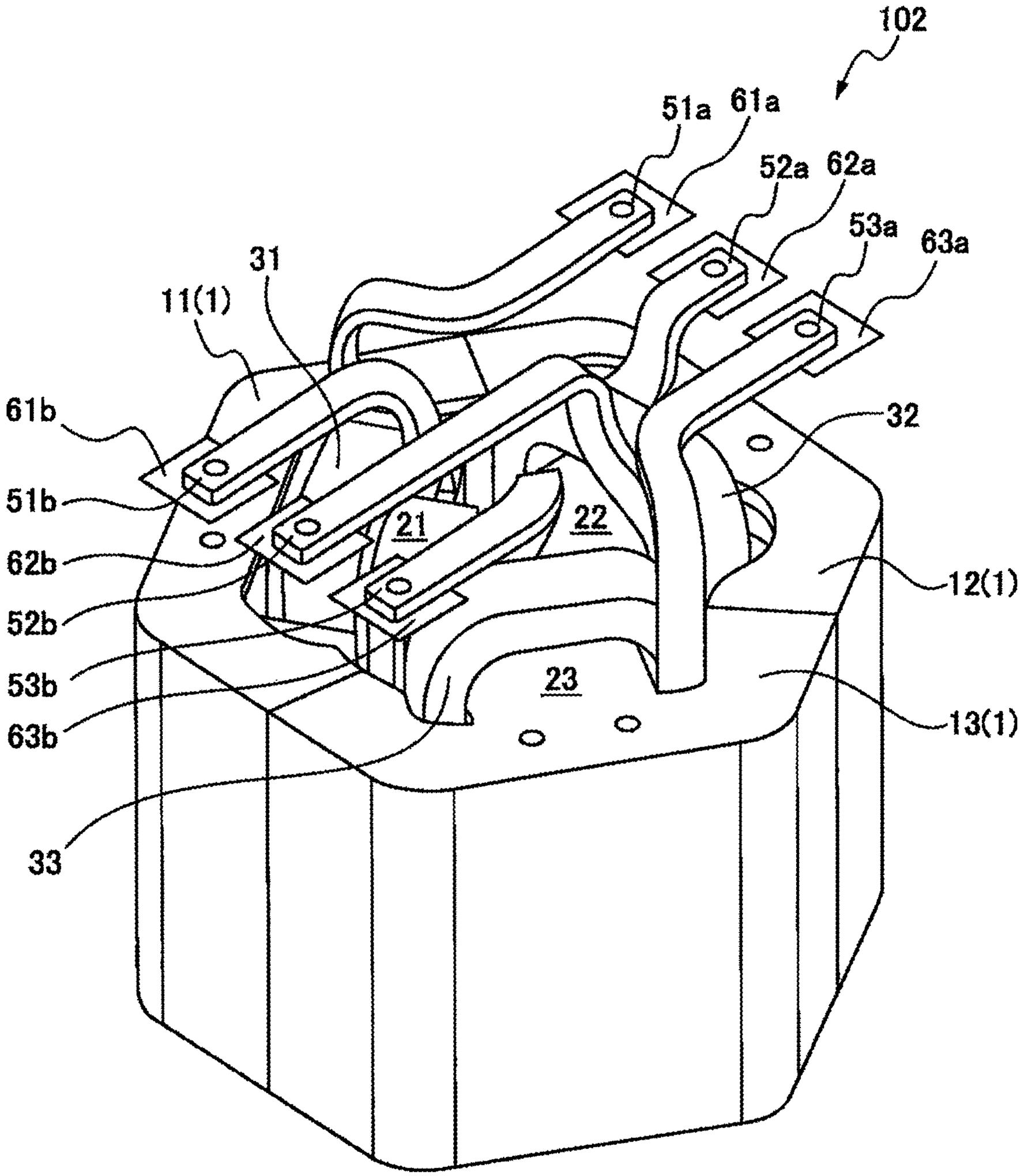

32b
Axial direction of the leg
32a
32
Winding direction

FIG. 6


102
51a
61a
52a
62a
53a
63a
31
11(1)
61b
32
51b
21
22
62b
12(1)
52b
53b
23
13(1)
63b
33

# REACTOR HAVING RELAY MEMBER WITH INPUT/OUTPUT TERMINAL

## BACKGROUND OF THE INVENTION

### 1. Field of the Invention

The present invention relates to a reactor and more particularly to a reactor having a relay member with an input/output terminal.

### 2. Description of the Related Art

Reactors are provided between a power supply side (primary side) and an inverter; or between a load side (secondary side) such as a motor, etc. and an inverter and are used to reduce inverter failure or to improve power factor in industrial robots and machine tools and the like.

As a reactor that prevents magnetic flux from leaking to the outside, there has been reported a three-phase reactor including a central iron core, an outer peripheral iron core surrounding the central iron core, and at least three connecting portions magnetically connecting the central iron core and the outer peripheral iron core, where the connecting portions include one or more connecting iron cores, one or more coils wound around the connecting iron cores, and one or more gaps (e.g., JP-A-2017-059805).

In the reactor in the related art, coils in which the positions of two terminals in each coil are the same are used for the three coils, and when connecting each of the terminals to a terminal block with a relay member for each of the three coils, there has been a problem that a shape of the relay member becomes complicated. In addition, when the relay members cross each other, there is a risk of shorting due to vibration or the like.

## SUMMARY OF THE INVENTION

An object of this invention is to provide a reactor which can prevent a shape of relay members connected to terminals of coils from becoming complex.

A reactor according to the embodiments of the present disclosure includes: an outer peripheral iron core; three leg iron cores provided on an inner surface side of the outer peripheral iron core and spaced apart from each other in a circumferential direction; and three coils wound around each of the three leg iron cores, each of the three coils having an input side coil end and an output side coil end projecting from a same end surface on an end side in the axial direction of the three leg iron cores, where the three coils include two first coils in which a projecting position of the input side coil end and a projecting position of the output side coil end at a portion projecting from the end surface have a first relative positional relationship, and one second coil in which the projecting position of the input side coil end and the projecting position of the output side coil end at the portion projecting from the end surface have a second relative positional relationship opposite to the first relative positional relationship, and a winding direction from the input side coil end to the output side coil end of the first coil and a winding direction from the input side coil end to the output side coil end of the second coil are reversed to each other.

According to a reactor according to the embodiments of the present disclosure, it is possible to prevent a shape of relay members connected to terminals of coils from becoming complicated. Further, since the relay members do not cross each other, the risk of shorting due to vibration or the like can be suppressed.



## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1**A is a perspective view of a reactor according to Example 1.

FIG. **1**B is a plan view of the reactor according to Example 1.

FIG. **2** is a plan view of the reactor according to Example 1, excluding a relay member.

FIG. **3**A is a perspective view of a reactor having a relay member of a complicated shape.

FIG. **3**B is a plan view of the reactor having the relay member of the complicated shape.

FIG. **4** is a plan view of the reactor in which the shape of the relay member is complicated, excluding the relay member.

FIG. **5**A is a perspective view of a coil in which coil ends have a first relative positional relationship.

FIG. **5**B is a perspective view of a coil in which coil ends have a second relative positional relationship.

FIG. **6** is a perspective view of a reactor according to Example 2.

## DETAILED DESCRIPTION

Hereinafter, a reactor according to the present invention will be described with reference to the drawings. However, the technical scope of the present invention is not limited to these embodiments and includes the present invention described in the claims and elements equivalent thereto.

FIG. **1**A illustrates a perspective view of a reactor **101** according to Example 1, and FIG. **1**B illustrates a plan view of the reactor **101** according to Example 1. FIG. **2** is a plan view of the reactor **101** according to Example 1, excluding relay members. The reactor **101** according to Example 1 includes an outer peripheral iron core **1**, three leg iron cores **21**, **22**, **23**, and three coils **31**, **32**, **33**.

The outer peripheral iron core **1** may include three outer peripheral iron core portions **11**, **12**, **13**, that is, the first outer peripheral iron core portion **11**, the second outer peripheral iron core portion **12**, and the third outer peripheral iron core portion **13**. The outer peripheral iron core **1** may have a substantially hexagonal annular structure. However, the outer peripheral iron core **1** may have a circular or other polygon shape.

The three leg iron cores **21**, **22**, **23** are provided on the inner surface side of the outer peripheral iron core **1** and are arranged spaced apart from each other in a circumferential direction. As illustrated in FIGS. **1**A and **1**B, the first outer peripheral iron core portion **11** and the first leg iron core **21** may be integrally formed, the second outer peripheral iron core portion **12** and the second leg iron core **22** may be integrally formed, and the third outer peripheral iron core portion **13** and the third leg iron core **23** may be integrally formed.

Three coils **31**, **32**, **33** are respectively wound around three leg iron cores **21**, **22**, **23**. The three coils **31**, **32**, **33** each have an input side coil end **31***a*, **32***a*, **33***a* and an output side coil end **31***b*, **32***b*, **33***b*, which project from a same end surface on an end side in the axial direction of the three leg iron cores **21**, **22**, **23**. The three coils **31**, **32**, **33** include two first coils **31**, **33** in which a projecting position of the input side coil end **31***a*, **33***a* and a projecting position of the output side coil end **31***b*, **33***b* at a portion projecting from the end

surface have a first relative positional relationship, and one second coil **32** in which a projecting position of the input side coil end **32***a* and a projecting position of the output side coil end **32***b* at a portion projecting from the end surface have a second relative positional relationship opposite to the first relative positional relationship, where a winding direction from the input side coil end to the output side coil end of the first coils **31**, **33** and a winding direction from the input side coil end to the output side coil end of the second coil **32** are reversed to each other. The three coils **31**, **32**, **33** may include flat wire, round wire or litz wire.

As illustrated in FIG. **2**, a positional relationship between the input side coil end **31***a*, **33***a* and the output side coil end **31***b*, **33***b* in the two first coils **31**, **33** of the three coils, that is, the positional relationship between the input side coil end **31***a* and the output side coil end **31***b* in one first coil **31**; and the positional relationship between the input side coil end **33***a* and the output side coil end **33***b* in the other first coil **33** are referred to as a first relative positional relationship. Further, a positional relationship between the input side coil end **32***a* and the output side coil end **32***b* in one second coil **32** of the three coils **31**, **32**, **33** is referred to as a second relative positional relationship. Here, the second relative positional relationship is opposite to the first relative positional relationship.

Specifically, focusing on a distance from a center O of the outer peripheral iron core **1**, the input side terminal **31***a* of the first coil **31** is closer to the center O than the output side terminal **31***b*, but the input side terminal **32***a* of the second coil **32** is farther from the center O than the output side terminal **32***b*. Also, although the first coils **31** and **33** are in rotational symmetry with each other about the center O of the outer peripheral iron core **1**, the second coil **32** is not in rotational symmetry with the first coils **31**, **33**.

Furthermore, three input terminals **61***a*, **62***a*, **63***a* to which the input side coil ends **31***a*, **33***a* of the first coils **31**, **33** and the input side coil end **32***a* of the second coil **32** are individually connected; and three output terminals **61***b*, **62***b*, **63***b* to which the output side coil ends **31***b*, **33***b* of the first coils **31**, **33** and the output side coil end **32***b* of the second coil **32** are individually connected are further provided, where the three input terminals **61***a*, **62***a*, **63***a* and the three output terminals **61***b*, **62***b*, **63***b* may be arranged to gather on opposite sides to each other on an end side in the axial direction.

Furthermore, it is preferable that first relay members **41***a*, **42***a*, **43***a* connecting the input side coil ends **31***a*, **32***a*, **33***a* to the input terminals **61***a*, **62***a*, **63***a* and second relay members **41***b*, **42***b*, **43***b* connecting the output side coil ends **31***b*, **32***b*, **33***b* to the output terminals **61***b*, **62***b*, **63***b* are further provided.

As illustrated in FIGS. **1**A and **1**B, by setting, in the two first coils **31**, **33** at the portion projecting from the end surface, the projecting position of the input side coil end **31***a*, **33***a* and the projecting position of the output side coil end **31***b*, **33***b* as a first relative positional relationship and by setting, in the one second coil **32** at the portion projecting from the end surface, the projecting position of the input side coil end **32***a* and the projecting position of the output side coil end **32***b* as a second relative positional relationship opposite to the first relative positional relationship, the three first relay members **41***a*, **42***a*, **43***a* and the three second relay members **41***b*, **42***b*, **43***b* can be arranged so that they do not intersect one another.

Then, a reactor having a relay member of a complicated shape in which the first relay member and the second relay member overlap will be described. FIG. **3**A illustrates a perspective view of a reactor **1000** having relay members of a complicated shape, and FIG. **3**B illustrates a plan view of the reactor **1000** having the relay members of the complicated shape. FIG. **4** is a plan view of the reactor **1000** in which the shape of the relay members is complicated, excluding the relay members. A first relay member **42***c* and a second relay member **42***d* overlap in a portion surrounded by a dotted line A in FIGS. **3**A and **3**B. The reason why the first relay member and the second relay member overlap is that the relative positional relationship between the input side coil end **31***a*, **32***c*, **33***a* and the output side coil end **31***b*, **32***d*, **33***b* in the coils **31**, **320**, **33** is the same in all the three coils **31**, **320**, **33**.

As illustrated in FIG. **3**B, the first relay member **42***c* connected to the input side coil end **32***c* of the coil **320** overlaps the second relay member **42***d* connected to the output side coil end **32***d* of the coil **320**. On the other hand, in the reactor **101** according to Example 1, as illustrated in FIG. **1**B, the first relay member **42***a* connected to the input side coil end **32***a* of the second coil **32** is arranged so as not to overlap the second relay member **42***b* connected to the output side coil end **32***b* of the second coil **32**.

In this regard, the positions of the input side coil end and the output side coil end in the coil where the coil ends have the first relative positional relationship and in the coil where the coil ends have the second relative positional relationship will be described. FIG. **5**A illustrates a perspective view of the first coil **31** which is a coil having a first relative positional relationship between the coil ends. FIG. **5**B illustrates a perspective view of the second coil **32** which is a coil having a second relative positional relationship between the coil ends. As can be seen from FIGS. **5**A and **5**B, in the reactor **101** according to Example 1, the first relative positional relationship between the projecting position of the input side coil end **31***a* and the projecting position of the output side coil end **31***b* at the portion projecting from the end surface of the first coil **31**; and the second relative positional relationship between the projecting position of the input side coil end and the projecting position of the output side coil end at the portion projecting from the end surface of the second coil **32** are opposite to each other. Furthermore, the winding direction from the input side coil end **31***a* to the output side coil end **31***b* of the first coil **31**; and the winding direction from the input side coil end **32***a* to the output side coil end **32***b* of the second coil **32** are reversed to each other. In this regard, when the coil ends **31***a* and **32***a* are used as input terminals and the coil ends **31***b* and **32***b* are used as output terminals, the current flow in the first coil **31** and the current flow in the second coil **32** are in the same direction so that the direction of the magnetic field generated by the second coil **32** is the same as the direction of the magnetic field generated by the first coil **31**.

By the reactor according to Example 1, the three first relay members and the three second relay members can be arranged so as not to cross each other so that the first relay member and the second relay member may not short out by vibration or the like.

Then, a reactor according to Example 2 will be described. FIG. **6** illustrates a perspective view of a reactor **102** according to Example 2. The difference between the reactor **102** according to Example 2 and the reactor **101** according to Example 1 is that the input side coil end **51***a*, **52***a*, **53***a* is directly connected to the input terminal **61***a*, **62***a*, **63***a*, and the output side coil end **51***b*, **52***b*, **53***b* is directly connected to the output terminal **61***b*, **62***b*, **63***b*. The other configuration of the reactor **102** according to Example 2 is the same as that

of the reactor **101** according to Example 1, and thus the detailed description thereof will be omitted.

As illustrated in FIG. **6**, in one first coil e.g., **31** of the three coils **31**, **32**, **33**, the projecting position of the input side coil end and the projecting position of the output side coil end have a first relative positional relationship, and in the other two second coils **32**, **33** of the three coils, the projecting position of the input side coil end and the projecting position of the output side coil end have a second relative positional relationship opposite to the first relative positional relationship.

The three coils **31**, **32**, **33** may include flat wire, round wire or litz wire.

According to the reactor according to Example 2, since the input side coil end is directly connected to the input terminal and the output side coil end is directly connected to the output terminal, the process of connecting the first relay member and the second relay member to the input side coil end and the output side coil end respectively can be omitted.

Although the example in which the coils **31** and **33** are used as the first coils and the coil **32** is used as the second coil has been described in the description of above Example 1, the present invention is not limited to such an example, but the coil **31** or coil **33** may be used as the second coil. In addition, even if the input side coil end and the output side coil end are interchanged, the reactors according to Examples of the present disclosure can be realized similarly.

The invention claimed is:

**1**. A reactor comprising:

an outer peripheral iron core;

three leg iron cores provided on an inner surface side of the outer peripheral iron core and spaced apart from each other in a circumferential direction; and

three coils wound around each of the three leg iron cores, each of the three coils having an input side coil end and an output side coil end projecting from a same end surface on an end side in an axial direction of the three leg iron cores;

the three coils including

two first coils in which a projecting position of the input side coil end and a projecting position of the output side coil end at a portion projecting from the end surface have a first relative positional relationship, and

one second coil in which the projecting position of the input side coil end and the projecting position of the output side coil end at the portion projecting from the end surface have a second relative positional relationship opposite to the first relative positional relationship; and

a winding direction from the input side coil end to the output side coil end of the first coil and a winding direction from the input side coil end to the output side coil end of the second coil being reversed to each other.

**2**. The reactor of claim **1**, further comprising;

three input terminals to which the input side coil ends of the first coils and the input side coil end of the second coil are individually connected; and

three output terminals to which the output side coil ends of the first coils and the output side coil end of the second coil are individually connected, wherein

the three input terminals and the three output terminals are arranged to gather on opposite sides to each other on the end side in the axial direction.

**3**. The reactor of claim **2**, further comprising:

first relay members, each of the first relay members connecting respective one of the input side coil ends to respective one of the input terminals; and

second relay members, each of the second relay members connecting respective one of the output side coil ends to respective one of the output terminals.

**4**. The reactor of claim **2**, wherein

each of the input side coils end is directly connected to respective one of the input terminals, and

each of the output side coils end is directly connected to respective one of the output terminals.

* * * * *